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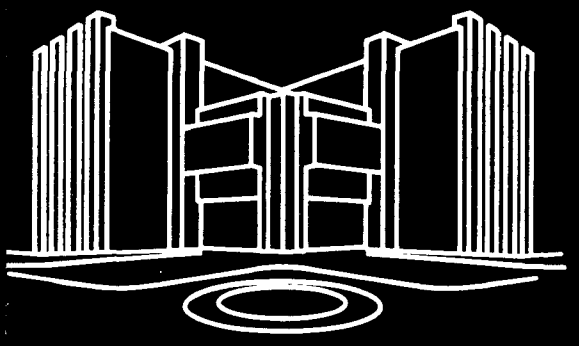
Water and Hazardous Waste Treatment Research Division

Advancing engineering science for environmental protection



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RREL

Risk Reduction Engineering Laboratory

Mission

Advance the understanding, development, and application of engineering solutions for the prevention and reduction of risks from environmental contamination

WHWTRD

Division Description:

The Water and Hazardous Waste Treatment Research Division (WHWTRD) is one of four operating Divisions within the Risk Reduction Engineering Laboratory (RREL). Through its three Branches, WHWTRD conducts a program of multimedia research, development, and demonstration of treatment technologies and related waste management strategies to control hazardous, toxic, and other pollutants. The WHWTRD program is carried out through a variety of mechanisms including: in-house research; cooperative agreements with

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colleges, universities, and not-for-profit organizations; contracts with environmental consultants and profit-making companies and Interagency agreements with other federal entities (e.g., USDA, DOE, Bureau of Mines). More recently, WHWTRD has been negotiating Cooperative Research and Development Agreements (CRDAs) with the private sector under the Federal Technology Transfer Act of 1986.

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RREL/WHWTRD

Biosystems Branch:

The Biosystems Branch is responsible for research, development, testing, and evaluation of biological treatment systems for controlling pollutants in air emissions, wastewaters, sludges, sediments, and soils. The Biosystems program stresses the scientific understanding of biotreatment for organically-contaminated soils at Superfund sites. It also includes research on bioremediation of oil spills, and biotreatment of hazardous wastes. Future research activities will be oriented toward improving

engineered systems for delivery of biotreatment materials and biologically separating and recycling metals contained in contaminated water, soil, and sediments. The ultimate aim of this work will be the practical, large-scale application of biological treatment systems in the field.

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RREL/WHWTRD

Physical/Chemical Systems Branch:

The Physical/Chemical Systems Branch is responsible for research, development, testing, and evaluation of physical and chemical treatment systems for air emissions, wastewaters (both municipal and hazardous), sludges, sediments and soils. The Physical/Chemical program currently stresses development and testing of innovative technologies for treating pollutants from all of the above waste streams Future research activities will be oriented toward the fundamental understanding and development of

improved systems for the management of municipal wastewaters, urban stormwater, and particularly difficult-to-treat wastes (e.g., mercury, arsenic, complex mixtures of organics and inorganics) Of particular interest are large volume wastes (e.g., contaminated sediments, mining wastes). The ultimate aim of this work will be the practical, large-scale application of innovative physical/chemical management and treatment systems in the field.

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RREL/WHWTRD

Toxics Control Branch:

The Toxics Control Branch is responsible for research, development, testing, and evaluation of treatment systems and control options for pesticides, industrial wastewaters, asbestos, and lead. The Toxics Control program currently stresses development and testing of innovative technologies for managing asbestos and lead in urban areas. Future research activities will be oriented

toward the fundamental understanding and development of improved systems for the management of both concentrated and dilute industrial waste streams. The ultimate aim of this work will be the practical, large-scale application of innovative management and treatment systems in the field.

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Key Research Areas

Oil Spills - Following the Exxon Valdez oil spill in Prince William Sound in 1989, staff from WHWTRD tested a number of nutrients and nutrient combinations to evaluate their effectiveness in facilitating the degradation of oil that had washed ashore. Since then, researchers from the Biosystems Branch have been investigating the ability of various commercially-available bioremediation products for controlling acutely toxic components and the efficacy of these products in various spill scenarios. The fate of the longer term toxic components during the bioremediation process is also being evaluated.

Toxicity Reduction Evaluations (TREs) - The Toxicity Reduction Evaluation (TRE) Protocol for municipal wastewater treatment plants was developed by the Biosystems Branch staff in the 1980s. The TRE Protocol provides a systematic framework for conducting TREs using bioassay endpoints and has been field-tested at a number of publicly-owned treatment works. Currently, work is underway to evaluate long-term, chronic bioassays for identifying specific toxicants and assessing their carcinogenic effects in fish.

Biosystems for Aqueous Hazardous Wastes - Many aqueous industrial wastes and leachates from contaminated sites contain hazardous components that vary widely in composition and strength. Biosystems to destroy

these hazardous components include granular-activated-carbon (GAC) assisted anaerobic treatment, GAC assisted aerobic treatment, and anaerobic/aerobic biotreatment. The Biosystems Branch is stressing novel reactor configurations to biodegrade these hazardous and often recalcitrant aqueous wastes and innovative approaches to control or eliminate inhibitory effects of the hazardous wastes on microbial activity.

Fungal Treatment - Researchers with the Biosystems Branch and the U. S. Department of Agriculture are investigating the abilities of lignin-degrading fungi to detoxify organic hazardous wastes. Efforts have focused on the treatment of pentachlorophenol and other organic chemicals associated with the wood preserving industry. The development of this technology has proceeded through a methodical investigation of growth requirements of the fungi and the pilot-scale testing of fungal treatment in soil to determine the conversion of pollutants to non-toxic end products. A field-scale evaluation of the technology is underway.

Engineered Biosystems for Soils and Sediments - The practical engineering problems associated with field-scale implementation of bioremediation technologies are being evaluated. Biological treatment systems of interest include, bioslurry reactors, composting, and land treatment applications. In situ biological treatment techniques such as bioventing are also under evaluation. WHWTRD is working with another RREL Branch, and other organizations to test various

delivery systems for in situ biological treatment

Air Biofilter Treatment - The emission of volatile organic compounds (VOCs) from various industrial and municipal sources poses a risk to human health. The Biosystems Branch, in cooperation with the University of Cincinnati, has developed improved gas-phase biofilters that rapidly and efficiently remove VOCs from air streams. Research on ways to improve the operation and reliability of these biofilters is ongoing at RREL facilities. Technology transfer will be undertaken with the private sector and other government agencies to accelerate the use of the technology.

Constructed Wetlands - Constructed wetlands offer several potential advantages for the treatment of a wide variety of wastewaters. However, many questions concerning their design, operation, and performance remain. The constructed wetlands research program involves three activities: (1) performance monitoring at operating full-scale constructed wetlands, (2) pilot-scale investigations constructed wetlands at Tennessee Technological University, and (3) performance evaluations of small subsurface flow wetlands for individual homes.

Contaminated Sediments - A research program was initiated in 1991 by the Physical/ Chemical Systems Branch to investigate and evaluate cost-

effective techniques for managing contaminated sediments. Preliminary efforts are aimed at *in situ* techniques for isolating or treating the contaminated sediments. Separation techniques that reduce the volume of sediment to be treated, and biological treatment of contaminated sediments in Confined Disposal Facilities are also being investigated. A large-scale engineering investigation using ore mining and beneficiation techniques is being monitored by Physical/Chemical Systems Branch staff, and talks are underway with the U. S. Department of Interior's Bureau of Mines (BOM) to cooperate on research where BOM mineral processing techniques might be employed to mitigate the problems of contaminated sediments.

Base-Catalyzed Dehalogenation - Many chlorinated organic products of commerce are toxic, and because of past practices, these products are found at high concentrations in the environment. In response to this problem, Physical/Chemical Systems Branch researchers have developed and patented a treatment technology called base-catalyzed dehalogenation (BCD). BCD removes chlorine from chlorinated organic wastes such as polychlorinated biphenyls (PCBs) and pesticides, thereby eliminating the waste's persistence and toxicity. Applications include

treatment of contaminated soils, contaminated oils from the electrical industry, and obsolete stocks of chlorinated chemicals

Urban Runoff - Included in urban runoff are stormwater and combined sewer overflows. Past research has focused primarily on end-of-the-pipe control. Some of the remaining questions include the value of pollution prevention or best management practices (BMPs) for control of urban runoff, possibilities for combined flood and pollution control, and the impact of these discharges on receiving waters. An effort was begun in 1991 to identify and provide a methodology for controlling improper cross connections to separate storm sewers. Another effort has been recently undertaken to characterize the runoff from specific land uses such as industrial sites, roads, parking lots, and homes.

Difficult-to-Treat Wastes - Over the past five years, the Physical/Chemical Systems Branch has supported the Office of Solid Waste and Emergency Response (OSWER) with technical performance data on various **Best Demonstrated Available Technologies (BDAT)** for treating RCRA hazardous and Superfund wastes. The bulk of this regulatory support effort is completed. However, wastes that are difficult-to-treat are still being produced by various industries,

and are also present at Superfund sites due to past disposal practices. In response to this need for effective technologies for difficult-to-treat wastes, Physical/Chemical Systems Branch staff have initiated a research program to identify existing techniques; or develop, test, and evaluate new techniques for such pollutants as lead, mercury, and arsenic. The first phase of this effort was experts' workshops on mercury and arsenic to identify effective waste management techniques; from pollution prevention, through recovery, recycle, reuse, treatment, and containment.

Electrokinetic Processes - Contaminated soils and industrial wastewaters often contain charged contaminants such as dissolved heavy metals. A research program has been initiated in the Physical/Chemical Systems Branch to study the use of electrokinetic processes in the remediation of contaminated soils and the recovery of charged pollutants from aqueous waste streams. Electrokinetics is composed of three phenomena (i.e., electroosmosis, electrophoresis, and electrolysis) related to the response of charged molecules or particles to an applied voltage gradient. Among these phenomena, electoosmosis and electrolysis are of particular interest. Electroosmosis, the movement of soil pore fluid from one electrode to another, can be utilized to remediate contaminated soils *in situ* by flushing out the pore fluid and contaminants and can be applied to soils containing charged

as well as uncharged contaminants. Electrolysis, the movement of aqueous ions and ion-complexes, can be used to recover contaminants from soil as well as to separate heavy metals from wastewater.

TRI Estimation Improvement - The Toxic Release Inventory (TRI) is a unique resource, envisioned from the outset as a way to provide publicly available data that could be used as a catalyst for pollution prevention activities at the community, state, and federal levels. A significant portion of the TRI data is based on estimations rather than measurements; therefore, it is critical that the estimates be as accurate as possible. Research to improve estimation techniques for difficult-to-estimate processes is the focus of activity in this area. This research effort will stress cooperation with industry and industrial trade associations to: (1) identify processes and operations needing estimation-accuracy improvement, and (2) develop the improved estimation techniques.

Separations for Wastes - Separation technologies (e.g., membranes, adsorption/absorption, stripping, extraction) have been receiving increased research and development funding from both industry and government. The application of separation technologies as end-of-pipe treatment is being replaced by the application of these technologies at up-stream process points to segregate pollutants before treatment and final discharge. New and innova-

tive applications of separation technologies are being researched by the Toxics Control Branch in cooperation with industry. Current projects include determining the use of separation technologies within key industrial classifications, investigating membrane processes for treatment of oil and gas production waters, and evaluating sorption, membrane, and oxidation processes for treatment of pesticide wastewaters.

Lead Paint Abatement - Lead from peeling house paint is a harmful toxicant, particularly to children. In response to this ever increasing concern about lead in the home, the Toxics Control Branch researchers have initiated a program to reduce children's exposure to lead. Although resources for this effort are quite limited, TCB staff are developing a Cooperative Research and Development Agreement (CRDA) with a company that uses dry ice (i.e., frozen CO_2) particle blasting to remove paint from aircraft. Modifications to the existing equipment are being developed in order to address various situations not encountered in aircraft paint stripping. Also, efforts are underway to locate a site for a field test of the modified technology.

Asbestos - Asbestos has been used for decades as a preferred, even mandatory, insulation and fire protection material in structures. Serious health effects may result from inhalation of fine, microscopic, durable asbestos fibers. The Toxics Control Branch has been working for a number of

years to reduce the risk to the public from asbestos exposure. Current research is emphasizing management-in-place and controls during operation and maintenance activities to minimize exposure. Research in the future will be focused on the conversion of asbestos wastes to less toxic forms and the evaluation of man-made fibers, which are increasingly being called into question.

Key Research Area Contacts

Biosystems Branch

Oil Spills

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RREL Treatability Database

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Research Facilities

Andrew W. Breidenbach Environmental Research Center (AWBERC): AWBERC houses several research organizations reporting to EPA's Office of Research and Development. The Risk Reduction Engineering Laboratory (RREL), of which WHWTRD is one division, is headquartered at AWBERC. WHWTRD operates 30 laboratory modules in AWBERC investigating proof-of-concept, bench-scale, and small pilot-scale technologies for treating various wastes of interest. The Electron Microscopy Laboratory, operated by the Toxics Control Branch, but offering services to all of AWBERC, is located on the third floor. Laboratories for investigating biological, physical, and chemical technologies are located on the fourth and seventh floors.

Test & Evaluation Facility (T&E Facility): The T&E Facility is a RCRA-permitted, research and development pilot plant in which new technologies for treating hazardous, municipal and industrial wastes are evaluated. The T&E Facility is a two-story building containing 24,000 square feet of high-bay space. It is located on the grounds of the Metropolitan Sewer District of Cincinnati and is designed to allow testing and evaluation of a broad spectrum of

technologies for waste treatment at the bench and pilot scale. The T&E Facility is available to non-EPA organizations if the research proposed supports the mission of RREL.

Products

RREL Treatability Database:

The RREL Treatability Data Base was designed to provide a thorough review of the effectiveness of proven treatment technologies in the removal and/or destruction of chemicals in various media such as municipal and industrial wastewater, drinking water, groundwater, soil, debris, sludge, and sediments. Version 4.0 of the data base was released in February 1992, and contains 1166 chemical compounds and over 9200 sets of treatability data. The data base has been developed using **Dbase III Plus** and compiled using **Clipper**. It is designed to operate on an IBM or IBM compatible (MS DOS) personal computer and is menu driven. The data base has the following hard- and software requirements:

- 8 megabyte hard disk storage
- 640 K RAM memory
- DOS Version 2.0 and 3.3 or higher
- 12 pitch printer

The data base is currently available free of charge. Copies can be obtained by mailing or faxing your request to the address that appears below. Please specify the type of program diskette required for your computer

(i.e., 3.5" high density or 5.25" high density).

WHWTRD Fact Sheets: Fact Sheets on all of the *aforementioned* **Key Research Areas** can be obtained by faxing a written request to the attention of the Division Director - WHWTRD, or by writing to the following address:

Division Director - WHWTRD (MS-497)

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